Emissions Estimates for HC, CO, SOx and PM

For informational purposes, we have included the preliminary estimates of hydrocarbons (HC), carbon monoxide (CO), oxides of sulfur (SOx), and particulate matter (PM) emissions for the August 3-7, 1997 SCOS97 episode. The emissions for these pollutants were estimated for South Coast Air Basin waters (SCW) and for the SCOS97 domain.

For motorships, emission factors for cruising and maneuvering main engines and generators were obtained from Lloyd's Register Marine Exhaust Emissions Research Programme. For auxiliary boilers, emission factors in pounds per hour were used. (Acurex, December 12, 1996 and ARCADIS, May 28, 1999)

The steamship emission factors for HC, CO, PM, and SOx were obtained from the U.S. EPA AP 42 document. (U.S.EPA 1985) The gas turbines emission factors for these pollutants were obtained from JJMA. (Remley, 1998)

Tables B-3 summarize emissions for baseline (uncontrolled) HC, CO, PM, SOx for main engines, generators, and auxiliary boilers for the August 3-7, 1997 episode for the SCW.

Table B-3
Baseline HC, CO, PM, SOx Emissions for Main Engines, Generators (Auxiliary Engines), and Auxiliary Boilers for the August 3-7, 1997 Episode

Pollutant	Main Engines (Tons)	Generators (Tons)	Auxiliary Boiler (Tons)	Total (tons)
HC	2.3	1.0	0.5	3.8
CO	7.3	3.3	1.5	12.1
PM	6.7	2.9	1.6	11.2
SOx	65.2	24.5	61.5	151.2

The gridded emissions model was used to calculate ship emissions for the modeling region and for the South Coast waters. As shown in Tables B-4 and B-5, HC, CO, PM, and SOx emissions vary from day to day, due to differences in activity.

Table B-4
Gridded Ship Emission Totals (tons) for Each Day in August 3-7, 1997 Episode for Entire SCOS Modeling Region.

	Aug. 3	Aug. 4	Aug. 5	Aug. 6	Aug. 7	Total	Average per day
HC	1.9	2.1	1.1	1.4	1.8	8.2	1.6
CO	6.0	6.8	3.5	4.5	5.7	26.4	5.3
PM	5.3	5.9	3.1	4.2	5.2	23.7	4.7
SOx	58.2	59.8	35.3	51.5	63.5	268.2	53.6

Table B-5
Gridded Ship Emission Totals (tons) for Each Day in August 3-7, 1997 Episode for South Coast Waters Only.

	Aug. 3	Aug. 4	Aug. 5	Aug. 6	Aug. 7	Total	Average per day
HC	0.9	1.0	0.5	0.6	0.9	3.8	0.8
CO	2.7	3.2	1.7	2.0	2.5	12.1	2.4
PM	2.5	2.7	1.5	1.9	2.5	11.0	2.2
SOx	32.2	30.5	18.7	28.0	39.9	149.3	30.0

Table B-6
HC, CO, PM, and SOx Emissions for Ocean-Going Vessels for August 3-7, 1997 Episode (SCW and SCOS domain)*

HC	SCW						SCOS				
	8/3/97	8/4/97	8/5/97	8/6/97	8/7/97		8/3/97	8/4/97	8/5/97	8/6/97	8/7/97
BASE	0.86	0.96	0.49	0.63	0.86		1.86	2.05	1.06	1.40	1.84
S1	0.78	0.85	0.42	0.58	0.74		1.77	1.93	0.99	1.37	1.68
S2	0.67	0.73	0.37	0.49	0.60		1.65	1.80	0.95	1.30	1.49
S3	0.74	0.81	0.41	0.55	0.69		1.74	1.89	0.98	1.35	1.62
ALTP	0.88	0.98	0.50	0.64	0.88		1.99	2.20	1.13	1.51	1.97
CO	SCW						SCOS				
	8/3/97	8/4/97	8/5/97	8/6/97	8/7/97		8/3/97	8/4/97	8/5/97	8/6/97	8/7/97
BASE	2.75	3.21	1.66	1.95	2.52		5.99	6.76	3.51	4.48	5.69
S1	2.51	2.85	1.42	1.79	2.14		5.73	6.37	3.28	4.38	5.20
S2	2.14	2.48	1.26	1.51	1.70		5.33	5.94	3.17	4.15	4.58
S3	2.38	2.73	1.39	1.70	1.96		5.61	6.23	3.24	4.29	5.01
ALTP	2.81	3.27	1.69	1.99	2.59		6.44	7.24	3.75	4.84	6.12

*Baseline numbers may vary due to rounding.

Table B-6 (continued)
HC, CO, PM, and SOx Emissions for Ocean-Going Vessels for August 3-7, 1997 Episode (SCW and SCOS domain).

PM	SCW						SCOS				
	8/3/97	8/4/97	8/5/97	8/6/97	8/7/97		8/3/97	8/4/97	8/5/97	8/6/97	8/7/97
BASE	2.46	2.73	1.45	1.87	2.49		5.31	5.88	3.14	4.21	5.19
S1	2.25	2.41	1.24	1.72	2.15		5.06	5.53	2.94	4.12	4.75
S2	1.91	2.06	1.09	1.45	1.75		4.70	5.14	2.83	3.91	4.21
S3	2.14	2.30	1.22	1.64	2.00		4.97	5.40	2.91	4.05	4.59
ALTP	2.51	2.79	1.48	1.89	2.55		5.69	6.31	3.35	4.52	5.55
SOx	SCW						SCOS				
	8/3/97	8/4/97	8/5/97	8/6/97	8/7/97		8/3/97	8/4/97	8/5/97	8/6/97	8/7/97
BASE	32.22	30.47	18.72	28.03	39.89		58.17	59.82	35.28	51.51	63.46
S1	30.18	27.48	16.80	26.61	36.71		55.84	56.48	33.50	50.62	59.31
S2	27.14	24.18	15.34	24.02	33.17		52.46	52.79	32.42	48.47	54.51
S3	29.28	26.47	16.70	25.85	35.59		55.11	55.38	33.31	49.92	58.15
ALTP	32.72	30.96	18.94	28.26	40.41		61.59	63.93	37.05	54.30	66.53

* Base= Basecase, S1 = Scenario #1, S2 = Scenario #2, S3 = Scenario #3, S4 = Scenario #4, and ALTP = Proposed Shipping Lane

The U.S. Navy provided day-specific ship activity data for navy vessels traveling in the SCOS97 domain during the August episode. (See Table B-2) Table B-7 summarizes the emission estimates for the SCOS97 domain only.

Table B-7
Baseline HC, CO, PM, SOx Emissions* for U.S. Navy Vessels for August 3-7, 1997 Episode (SCOS domain).

HC (Tons)	CO (Tons)	PM (Tons)	SOx (Tons)
3	36	2	11

Due to time constraints, we have not been able to grid these emissions.

Estimate of Emission Reductions Attributable to the Precautionary Zone Speed Limit of 12 knots

To approximate the emission reductions that could be attributable to the 12 knot speed limit that was voluntarily instituted in 1994 we compared the expected emissions during the August episode under two assumptions: 1) assuming ships are abiding by the precautionary zone speed restriction of 12 knots; and 2) assuming the ships maintain cruise speed in the precautionary zone. As shown in Table B-8, the difference in emissions that can be attributed to the precautionary zone control (PZC) is approximately 5 tons during the episode or about a 6% reduction in cruising emissions. To estimate the impacts of the PZC on the 1997 SIP 2010 shipping emissions, we applied the control factor (0.06) to the projected 2010 cruise emissions for ocean-going ships adjusted for no PZC (27.8 T/D) in the 1997 SIP for the SCAB. This results in approximately a 1.7 T/D reduction that can be attributed to the PZC in 2010. This is a rough estimate as a more exhaustive analysis would need to consider the actual speeds that ships would travel in the precautionary zone without controls (i.e. ships may not be able to maintain cruise speed up to the breakwater) and differences in ship activity between 1997 and 2010.

Table B-8
Precautionary Zone Cruise (PZC) Air Quality Benefit
NOx Calculations for the August 3-7, 1997 Episode
(Ocean-going Cruise Emissions in the SCAB)

	Base Case*	No PZC Limit
	(Tons)	(Tons)
Cruise Main Engines	69.50	69.50
Cruise Generator	3.60	3.60
PZC Main Engines	11.40	5.70
PZC Generator	0.59	0.80
All Cruise Aux. Boiler	0.05	0.40
Episode Total	85.14	80.00

Ems Reduction for 5-Day Episode	NOx (tons)
	5.14

*Base Case = PZC without the 12-knot speed limit implemented
No PZC Limit = PZC with 12-knot speed limit not implemented, ships are assumed to travel at cruise speed in the precautionary zone

Appendix C

SCOS 97 Episode Classification

SCOS97 Episode Classification

An analysis was conducted to classify all days in 1997 including the SCOS97 episodes on the basis of the meteorological potential for ozone formation. The analysis utilized the Classification and Regression Tree Analysis (CART) ozone decision tree developed by Horie (1989) as a methodology for sorting and ranking each day into ten categories of ozone potential (terminal nodes). The Horie CART analysis classified the South Coast Air Basin daily maximum 1-hour average ozone concentration using daily surface wind characteristics and early morning upper air temperature profile in the coastal plain. Of the ten categories identified by CART, four categories (Episode Types I through IV) have been used to identify candidate meteorological episodes for regional modeling analyses conducted in support of the District's Air Quality Management Plan.

An air quality and meteorological database, consistent with that used by Horie's analysis, was constructed for each day in 1997. Using the CART tree as a map, each day was sorted based upon the observed daily meteorological profile. The results of the classification analysis are presented as a frequency distribution in Table C-1. Also presented in Table C-1 is the classification of the dependent data used by Horie for reference.

Table C-1
Classification of the 1997 Ozone-Meteorological Stagnation Potential

Horie CART Episode		1997 Distribution			Horie's Dependent Data (1982-1983)		
Ozone Potential	Met Class	Terminal Node	Number Count	Frequency Percent	Terminal Node	Number Count	Frequency Percent
Low		1	75	20.5	1	187	17.1
		2	35	9.6	2	199	18.2
		3	39	10.7	3	91	8.3
		4	18	4.9	4	113	10.3
Medium	Type IV	5	53	14.5	5	170	15.5
	Type III	6	81	22.2	6	86	7.8
		7	6	1.6	7	23	2.1
	Type II	8	25	6.8	8	124	11.3
	Type I-E	9	26	7.1	9	24	2.2
High	Type I	10	7	1.9	10	78	7.1

Analysis of the 1997 frequency distribution indicates that there were fewer low ozone potential days in 1997 than 1982-83 and roughly equivalent number of medium potential Type-IV ozone days for both periods. What is indicated in Table C-1 is that in 1997 there were fewer Type I and Type II episode days having higher potential for ozone and a greater number of Type III days where moderate levels of ozone were expected. Interestingly, in 1997 there was a reversal in the frequencies between terminal nodes nine and ten. Terminal node ten is a Type-I high potential ozone episode. Terminal node nine occurs under a similar meteorological profile as node ten however, a coastal eddy is typically developing and ozone potential is partially diminished under a lifting inversion.

Observations analyzed as part of the SCOS97 intensive monitoring forecasting program confirmed the frequency of eddy development during the summer months. The reduced ozone potential is indicative of the El Niño weather circulation that was building that summer.

Table C-2 lists the dates when the SCOS97 when intensive monitoring took place and the ozone-meteorological episode classification for each day listed. The majority of the days are classified as Horie episode categories I through III. The I-E eddy category is observed most frequently.

Table C-2
SCOS97 Intensive Monitoring Day Classification

Event Number	Date	Episode Node	Horie Category
1	8/4	9	I-E
2	8/5	9	I-E
3	8/6	9	I-E
4	8/7	10	I
5	8/22	9	I-E
6	8/23	9	I-E
7	9/3	6	III
8	9/4	10	I
9	9/5	6	III
10	9/6	8	II
11	9/22	6	III
12	9/23	9	I-E
13	9/27	6	III
14	9/28	8	II
15	9/29	6	III
16	10/3	5	IV
17	10/4	8	II
18	10/30	5	IV
19	10/31	6	III
20	11/1	9	I-E

Table C-3 lists the average resultant winds that were calculated for terminal nodes five through ten at seven District air monitoring stations located along the coast or in the coastal plain. The wind direction indicates where the wind vector originated. The net distance traveled through the wind monitoring station is also presented. What is evident from the calculation is that in 1997 the wind direction does not vary greatly by episode category. This is consistent even when the Type I-E eddy pattern is observed. Transport however is greatest for the Type I and Type II episodes (listed in terminal nodes 8 and 10). At the three stations closest to the coast (Hawthorne, Long Beach and Costa Mesa) transport for episode Type I-E is almost equal to the Type I episode.

The results of this episode classification indicate that the SCOS97 intensive field program captured meteorological episodes that were ranked in the top categories using the Horie model. Furthermore, while several of the episodes where characterized as Type I-E the wind analysis indicates that there was little difference in the net transport between a Type I and Type I-E episode at the coastal air monitoring stations.

Table C-3
1997 Average Resultant Wind Direction and Net Transport Miles for Terminal Nodes Five Through Ten
(Winds are from the direction listed. The 12-hour average includes hours 7 - 18.)

Station	Period	Variable	Pattern					
			5	6	7	8	9	10
West LA	24-Hr	Dir	217	222	214	222	212	216
	24-Hr	Miles	39	42	38	44	39	49
	12-Hr-	Dir	220	224	220	223	218	219
	12-Hr	Miles	38	37	37	41	39	46
Hawthorne	24-Hr	Dir	251	244	238	247	241	*243
	24-Hr	Miles	57	68	51	67	76	*107
	12-Hr-	Dir	251	244	238	246	246	*245
	12-Hr	Miles	45	54	47	52	58	*69
Central LA	24-Hr	Dir	244	240	235	246	242	235
	24-Hr	Miles	50	61	49	61	47	65
	12-Hr-	Dir	238	237	234	239	240	236
	12-Hr	Miles	45	48	40	49	47	57
Lynwood	24-Hr	Dir	210	213	205	217	221	218
	24-Hr	Miles	49	54	45	56	56	59
	12-Hr-	Dir	212	215	210	219	223	220
	12-Hr	Miles	38	41	35	44	44	47
Long Beach	24-Hr	Dir	201	204	192	217	231	223
	24-Hr	Miles	30	34	28	31	35	38
	12-Hr-	Dir	202	208	199	217	227	221
	12-Hr	Miles	26	28	25	26	29	32
Anaheim	24-Hr	Dir	203	212	192	217	231	223
	24-Hr	Miles	41	49	41	39	41	49
	12-Hr-	Dir	213	219	211	217	223	221
	12-Hr	Miles	31	36	31	30	32	39
Costa Mesa	24-Hr	Dir	238	238	212	237	243	234
	24-Hr	Miles	27	30	27	35	39	40
	12-Hr-	Dir	242	243	224	245	246	236
	12-Hr	Miles	25	26	24	30	33	36

* One Sample

References

Horie, Yuji, Ozone Episode Representativeness Study for the South Coast Air Basin , Appendix 5-P, 1989 Revision to the Air Quality Management Plan.

APPENDIX D

Summary of Comments and Responses

Summary of Written Comments and Responses

On April 14, 2000, the working draft of the TWG report,"Air Quality Impacts from NOx Emissions of Two Potential Marine Vessel Control Strategies in the South Coast Air Basin," was released for comment. Comment letters were received from the U. S. EPA, the Port of Long Beach, and the Steamship Association of Southern California. Below we provide a summary of written comments received and our responses.

Key:	POLB	Port of Long Beach, May 10, 2000
	U.S. EPA	United States Environmental Protection Agency, May 5, 2000
	SASC	Steamship Association of Southern California, May 12,2000

1. Comment: *We believe there are errors in the calculations of transit time for the various vessels....... Until the transit times in each scenario have been checked and calculated if necessary, none of the scenarios appear valid.* (SASC)

Response: We have made the necessary corrections.

2. Comment: *Many of the new container vessels that have entered the trade in the past twelve to eighteen months and that are entering today have new larger engines that will have a variety of impacts on any proposed rule. For example, we have learned the engines in the ships of a large Danish owner must use an auxiliary diesel to assist the engine's turbo charger when the vessel's speed reaches 18 knots or less. Thus, we may loose some NOx benefits by reducing this vessel's speed to 15 knots or 12 knots.* (SASC)

Response: Estimating the effect of this information on the emission reduction estimates for the speed reduction strategy is not straightforward and is probably best addressed in conjunction with a revision to the baseline inventory. Regardless, the results of the comparative analysis are not dependent on future projections of emissions and this new data does not modify the conclusions in the report.

3. Comment: *The vessel used in the base case, the M/V "Tundra King" has only called at LA/LB once in the past five years, thus it is not representative of vessels that call at the San Pedro Bay ports.* (SASC)

Response: In the analysis of the impact of shipping emissions, we looked at the aggregate ship emissions during the episode. The analysis was not designed to evaluate the emissions from individual ships. In the aggregate, the numbers and proportions of ship types traveling the shipping lanes during the August episode are consistent with data available for 1997 (See Table D-1). While we acknowledge there are some differences, we believe that the data available demonstrates that there are not substantial differences between the episode ship types/numbers and those for other years. Based on this comparison, we believe the data is representative of the ships using the San Pedro Ports.

Table D-1
Ship Calls by Ship Type

Ship Type	Ocean Going Vessels Calling on the Ports of Los Angeles and Long Beach as a Percent of Ship Type for the Time Period Identified	
	August 97 Episode	1997*
Auto	6.9%	5.02%
Bulk Carrier	13.7%	16.4%
Container Ship	54%	44.8%
General Cargo	3.4%	4.6%
Passenger	3.4%	6.1%
Reefer	3.4%	5.2%
Roll-on/Roll-off (RORO)	1.1%	1.2%
Tanker	13.7%	14.1%
Average Number Ships per Day	17	14

* Data taken from "Marine Vessels Emissions Inventory Update to 1996 Report: Marine Vessel Emissions Inventory and Control Strategies,"Arcadis Geraghty & Miller, 23 September 1999 prepared for the South Coast Air Quality Management District.

4. Comment: Page 1, *Executive Summary. The first bullet near the bottom of the page ("the voluntary ...") is a bit wordy. Can it be rewritten so that its meaning is more easily understood?* (U.S. EPA

Response: The first bullet was rewritten as requested.

5. Comment: *Page 3, Public Consultative Process. It's probably not necessary to mention the three workgroups since this report focuses only on Deep See Vessel/Shipping Channel issues.* (U.S. EPA)

Response: The section was modified as suggested.

6. Comment: *Page 4, 2nd paragraph. Last sentence should be past tense (i.e., "Participation was open ..."). page 4, last paragraph, 1st sentence. Same comment as above.* (U.S. EPA)

Response: We included the suggested revision into the report.

7. Comment: *Page 5, last sentence. The last portion of the sentence should be reworded. "... that may need to be considered ~~evaluated~~ when a decision is made regarding the most appropriate operational control for marine vessels. ~~U.S. EPA undertakes a formal rulemaking~~* (U.S. EPA)

Response: We included the suggested revision into the report.

8. Comment: *Page 7, Table II-1. Please provide references for the information, especially for average MAREX and average design speed.* (U.S. EPA

Response: We added references to Table 11-1 as requested.

9. Comment: *Page 10, last sentence in partial paragraph at the top of the page (and elsewhere in the report). The mention of photochemical analysis needs to be clarified. The need for photochemical analysis is stressed elsewhere (most notably on p12 and in the conclusions), but there is no real discussion of why photochemical modeling is needed. What additional information would it provide? If the options were modeled using photochemical analysis, could it possibly change the conclusions? If so, how? The report also implies that photochemical modeling will be done later. This could be interpreted as all of the options will be modeled, but from the last meeting, our understanding is that only the preferred option will be modeled. We are not suggesting that mentioning the need for photochemical modeling should be deleted from the report, we are recommending that the issue be further explained. (U.S. EPA*

Response: We provided further explanation in the discussion on photochemical modeling included in Appendix A, "Scope of Analysis."

10. Comment: *Pages 11 and 12, Scope of Analysis. As discussed at the last meeting, it may make sense to move these issues to an appendix. You could state in the report that because of time and resource considerations, the report did not address the issues listed in Appendix ( ). Also, we recommend that the reference to future actions should be rewritten as: ~~will need to be addressed by U.S. EPA when a rulemaking is undertaken.~~ may need to be considered when determining the most appropriate operational control for marine vessels. (*U.S. EPA)

Response: We added a new Appendix A which describes the "Scope of Analysis." Any reference to future U.S. EPA actions were rewritten as suggested.

11. Comment: *Page 12. For the issues that may need additional analysis (e.g., Impacts beyond SCAB Boundaries; Economic, Logistic and other impacts), can wording be added stating that EPA intends to continue to work with members of the TWG to assist in resolving the issues?* (U.S. EPA)

Response: We included wording as suggested by U.S. EPA.

12. Comment: *Page 76. 1st paragraph. Please delete to fulfill their obligations in the 1994 Ozone SIP. EPA has never agreed that they were obligated to fulfill the reduction targets in the 1994 SIP. Also, please rewrite the last sentence. It would be much cleaner to say that the TWG agreed to limit its analysis to the SCAQMD and that impacts to upwind*

and downwind areas may need to be considered when determining the most appropriate operational control for marine vessels. (U.S. EPA)

Response: The reference in the first paragraph to U.S. EPA's role in the SIP was reworded to be consistent with the language in the January 8, 1997 Federal Register notice approving the California SIP. The last sentence was reworded to improve the readability.

13. Comment: *Page 79, Table VI-4. There needs to be some explanation, methodology, and a spreadsheet that shows how to reductions were calculated. (This could be placed in an appendix.) The footnote below the table indicates that the control factors were multiplied times the projected 2010 NOX emissions (26.2 tpd). Please clarify what emission sources make up the 26.2 tpd estimate. Is this only cruise emissions or does it include maneuvering and hoteling? How does the 26.2 estimate account for current reduced speed in the precautionary zone?* (U.S. EPA)

Response: We modified this section to better describe the methodology used for estimating potential SIP credits from the various control strategies.

14. Comment: *The purpose of the Windfield Validation analysis is to determine whether the results of the tracer study are sufficiently well represented by the model simulations, that there is a reasonable expectation that model results for other simulated periods can be accepted as meaningful. In fact, the attempts to replicate the tracer results by means of modeling were inconclusive at best. In general, the calculated onshore fluxes were much lower for the tracer measurements than in the model simulations, and only 2-10 percent of the tracer mass released was accounted for by the measurements. The one possible explanation for this discrepancy that is never raised in the report is that less of the real tracer may have actually come onshore than the model predicted. It is encouraging that the modeling was able to conserve tracer mass during the simulations, but that does not mean the model was replicating reality. The fact that most of the real tracer mass apparently was not detected at the monitors onshore is masked in Figures V9-V13, by the practice of normalizing the results for each tracer (dividing each calculated percentage flux by the highest calculated value). When this is done the apparent percentages of tracer mass coming on shore in different areas more closely match the magnitude of values predicted by the model, but it is not clear whether this actually reflects better model performance. Calculation of correlation coefficients for the various comparisons that are presented between model-predicted and measured parameters would help to clarify this issue.* (POLB)

Response: The objective of the Model Validation portion of the analysis was to demonstrate that the simulated results were consistent with those observed from the tracer experiment. In the analysis, this consistency was illustrated by comparing the *relative* mass distributions from the simulation results to that estimated from the observations. This analysis was limited by the fact that there is no straightforward way to accurately estimate mass flux from observational data for reasons listed in the report. Among these reasons are lack of knowledge of the vertical distributions of the tracer concentrations and limited knowledge of the horizontal distribution based on the spatial resolution of the sampling network relative to the scale of the tracer plumes. We agree that the conclusions from the analysis must be interpreted in this light.

However, we believe that the observational data from the experiments suggest that the tracer material came onshore in relatively narrow plumes. In many cases, the plumes were so narrow that the various tracers were only detected at one or two sampling points along the coastline. We acknowledge the limited sampling network in Ventura and San Diego Counties, however peak tracer concentrations were recorded well within the limits of the sampling network. These observations are consistent with the assumption that most of the tracer mass came onshore within the limits of the sampling network.

We acknowledge that only 2-10 percent of the tracer mass was accounted for in the calculations based on the observed tracer concentrations. Those numbers could easily have been increased by reviewing the assumptions made about the horizontal and spatial distributions of the tracers on an hour-by-hour basis. However, any such assumptions would not change the *relative* mass distribution. The comparisons between the simulated and observed mass fluxes were based on *relative* concentration distributions. Thus, even if different assumptions were made to increase the observed mass, the simulated relative mass distribution that did come onshore would remain consistent with that calculated from the observations.

15. <u>Comment</u>: *The wind fields were peer reviewed for the period August 3-7, but not for September 4-5. Day-specific emissions data were available for the August period, but not for the September period (which was modeled with August emissions). It would appear that more confidence should be placed in the results of the August 3-7 model simulations, for which the proposed shipping lane scenario was predicted to produce the largest or second largest emission reductions on four of the five days and was less effective than speed reductions only on a day for which the predicted concentrations were very low. Although the simulations for September 4-5 are flawed by the attempt to superimpose emissions and meteorology from different periods, those results also indicated more beneficial impacts for the proposed shipping lane on two of the three days. It is therefore quite surprising that the study concludes from these results that the speed reduction control approach is preferable to the proposed shipping lane approach.* (POLB)

<u>Response</u>: Although peer review of the September episode was not completed, some peer review of that episode did occur (as well as the windfield validation). Areas of concern for that episode were investigated with a sensitivity simulation; this simulation suggested that the modeling results were not sensitive to the identified concerns.

The TWG agreed that the August 3-7 emissions were typical enough to be used for the September episode. It is worth noting, however, that there is no physical link between the pattern of offshore emissions on any given day and the meteorological patterns. In effect, the offshore emissions and the meteorological flow patterns for each day represent random samples wherein, from a probability standpoint, any combination of offshore emissions and meteorology can occur on any given day. In the report, this issue was addressed in the discussion of variations in daily emissions (see pages 71-73).

The conclusions of the report are based on analysis results showing that the relative impact of the alternative shipping lane can vary widely from one day to the next, and may even result in a significant disbenefit on some days, while the relative impacts from the speed-control scenarios are consistently beneficial. This finding was consistent between the tracer analysis and modeling results.

16. Comment: *The data presented for the route of the tracer release on the September afternoon offshore proposed shipping alternative test (Figure IV-3) shows that 40 percent of the tracer emissions being released were within 25 miles of the shore, as compared no tracer emissions being released within this region for the August afternoon proposed alternative channel route test (Figure IV-2). Due to the variations in the locations, results would be expected to vary significantly, as seen in the results. It would seem that the August event is more representative of the proposed shipping channel alignment. This, combined with the validated data for August time period and the actual ship inventory, indicate that the August data provides a better set of comparisons for review.* (POLB)

Response: As discussed in Chapter V, actual shipping emissions were simulated along the ship paths. For the early September episode, the August emissions were used as per the TWG. However, any combination of offshore emissions and meteorology can occur on any given day. We believe that the consistency in findings between the tracer and simulation analyses adds to the credibility of the results for both episodes.

17. Comment: *The conclusions on page 43 that the proposed shipping channel resulted in increased impacts on San Diego are based upon only three observations during three of the tests. Furthermore, one of the observations was orders of magnitude below the other averaged values (Table IV-12). Accordingly, those conclusions should be removed from the report* (POLB)

Response: We agree that the conclusions regarding San Diego are based upon very limited data (one monitoring site), and have removed those conclusions from the report.

18. Comment: *The meteorological interpolation used in CALMET employed interpolation barriers to limit offshore extrapolation from onshore wind monitoring sites. However, on page 45, Figure V-2, there is no offshore/onshore barrier used to restrict onshore influences to offshore wind flow as it enters the SCAB, as done near the Ventura County shoreline. Since there were very few sites offshore and no barriers, the modeling would allow a stronger influence of onshore monitors when calculating offshore wind flow patterns, thus biasing the meteorological wind field for subsequent analyses.* (POLB)

Response: The interpolation barrier used with CALMET offshore of Ventura and Los Angeles Counties is based on the understanding that NNW winds offshore are stronger along this portion of the coastline than they are further south (which is partly protected by the Palos Verdes peninsula). This understanding is supported by the results of the September tracer experiment which showed tracer material released near Anacapa Island coming onshore in Orange County. However, it is not considered unique to the September episode period.

19. Comment: *In the CALGRID modeling for the morning existing channel - PDCH (page 48) and the morning proposed channel - PTCH (page 49) it is unclear why the overland mass increases as soon as the release is made. It would appear that the mass would need travel time over water reaching the shore, as seen in the PMCH, PMCP, and PDCB analyses (pages 48-50).* (POLB)

Response: The observed feature is an artifact of Eulerian models. It can be characterized as the result of numerical or "artificial" diffusion. While ships are acknowledged point source, the minimum spatial resolution of the model is 5 km. Thus, after the first incremental time step (about 8 minutes), any emissions fill a three-dimensional 5x5x5 km grid cell. During the second time step, some of the mass is diffused into adjacent grid cells. Model output occurs after 60 minutes, or approximately 8 time steps. Thus, diffusion in an Eulerian model is typically greater than in the real world.

20. Comment: *The report appears to rationalize poor relationships between observed and predicted results on page 54, first paragraph (and page 60). It is true that a plume produced by a stationary point source may not hit a specific receptor location. However, the ships are not a stationary point source, but are more accurately represented as a line source over time. Accordingly, the argument presented is not valid.* (POLB)

Response: We acknowledge that a single moving ship is a moving point source. However, that does not invalidate the point being made. In an ideal case, the emission source would be moving parallel to the coastline with winds perpendicular to the coastline. In such a case, the plume would be detected all along the coast and would be easy to characterize. Unfortunately, during the tracer experiments the tracers released offshore where detected onshore at only a few sites, suggesting relatively narrow plumes relative to the spatial density of the sampling network. In such instances, the chances of being able to determine the peak concentration within the plume were limited.

21. Comment: *The first five sections of the report allow a reader to draw one of two conclusions: (1) the study is inadequate as a basis for selecting among the control alternatives; or (2) the proposed shipping lane may reduce onshore impacts on more days than the speed reduction measures, including more days when the potential for significant onshore advection of shipping emissions is highest. Section VI alters these results by adjusting their significance according to their likelihood of occurrence. This is accomplished by the application of some weighting factors that purport to incorporate consideration of the relative frequencies of the conditions under which different results were obtained. There is a reference to an analysis of ozone episode categories in Appendix B, but the manner in which these weighting factors are derived from that analysis is not explained either in Section VI or in Appendix B. The reader is asked to take this final adjustment of the study results on faith, and to accept that this is the justification for showing a more favorable result for the speed scenarios. The technical basis for this weighting procedure, which reverses the results that would otherwise have to be reported, must be made clear.* (POLB)

Response: We believe that the most obvious conclusion from the report is that the relative impact of the alternative shipping lane can vary widely from one day to the next, and may even result in a significant disbenefit on some days, while the relative impacts from the speed-control scenarios are consistently beneficial. This finding was consistent between both the tracer analysis and modeling results. Of the types of days analyzed and simulated, it is certainly true that there is a dispersion benefit for more types of days for the alternate shipping lane. However, the analysis of frequency of occurrence of the different days in 1997 showed that the type of day for which there was a disbenefit to the alternate shipping lane was more prevalent than the other types of days.

We acknowledge that the presentation of and discussion about the use of the frequency distributions needs to be expanded and clarified and have revised the discussion as recommended.

22. Comment: *One of the primary reasons for advocating of the alternate shipping lane has been the premise that emissions released further offshore will generally reach onshore areas of the SCAB less often than emissions closer to shore. This issue is not addressed by this study, which only analyzed/modeled days when some onshore flow was known to occur. In fact meteorological frequency issues are not brought into the analysis at all until the final presentation of the findings, and as noted previously, the technical basis for these final adjustments is not explained.* (POLB)

Response: As indicated above, we agree that the discussion about the use of the frequency distributions needs to be clarified and have revised this section to provide more explanation. We appreciate the comment that the analyses conducted for this study did not address all types of offshore flow days. That task was beyond the limited scope of this study, and would require a great deal of resources and data that are not currently available.

23. Comment: *We agree that photochemical modeling that includes the contributions of all NO_x and VOC sources within the air basin is needed to assess the relative benefits/disbenefits of the alternate control measures. In fact, modeling of NO_x as an inert pollutant and relying on the calculations of relative dispersion of shipping emissions as a basis for evaluating NO_x control options could lead to misleading results. Depending on the VOC/NO_x ratios in specific areas, higher NO_x concentrations moving onshore could act either to increase or to decrease local ozone levels.* (POLB)

Response: From a technical standpoint, we would agree that photochemical modeling could potentially provide additional information on the fate of shipping NO_x emissions in the context of the overall inventory, assuming satisfactory model performance. However, the decision to not include photochemistry in this analysis was made by the TWG early in the process, based on the unavailability of a complete emissions inventory and due to the preliminary standing of the SCOS meteorological inputs. Please see the response to Comment #9.

24. Comment: *Based upon Item 3 above, it would appear that the report incorrectly states (in the last paragraph on Page 9) that the onshore emission impacts were compared with the results from tracer tests to perform a comparative analysis. Since a majority of the comparisons were performed on the September event and the September data was not validated, these comparisons are suspect.* (POLB)

Response: We modified the last paragraph to improve the clarity. With regards to using the September episode, as stated previously in the response to Comment #15, the TWG agreed the August 3-7 emission were representative of typical shipping emissions and could be used for the September episode.

25. Comment: *On Page 14, first line, it should state, "...emission rates for auxiliary boilers and diesel engines were obtained from Lloyds...."*.(POLB)

Response: The correction has been made.

26. Comment: *The last sentence on Page 20 is inaccurate. In general, steamships do not have auxiliary boilers.* (POLB)

Response: This paragraph has been revised.

27. Comment: *Table III-8 on Page 22 does not appear to represent appropriate transit times for the cases. Although there is a change to the entry column for Scenario #2, other columns appear questionable. The exit times for Base Case and Scenario #3 are the same, even though there is a 15 mph speed restriction on the ships out to the SCAB overwater boundary. Also, entry times for the Base Case are greater than Scenario #1 for all ships, with a 12 mph restriction from 20 miles out. Entry times are identical for Base Case and Scenario #3 for most of the ships.* (POLB)

Response: Table III-8 has been revised.

28. Comment: *Figure II-2 on Page 9 should actually be credited to "control of Ship Emissions in the South Coast Air Basin", August 1994, prepared by the Port of Los Angeles and the Port of Long Beach.* (POLB)

Response: We agree there was an error and have made the suggested revision.

South Coast
Air Quality Management District
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Air Quality Significance Thresholds

Mass Daily Thresholds[a]		
Pollutant	**Construction** [b]	**Operation** [c]
NOx	100 lbs/day	55 lbs/day
VOC	75 lbs/day	55 lbs/day
PM10	150 lbs/day	150 lbs/day
SOx	150 lbs/day	150 lbs/day
CO	550 lbs/day	550 lbs/day
Lead	3 lbs/day	3 lbs/day
Toxic Air Contaminants (TACs) and Odor Thresholds		
TACs (including carcinogens and non-carcinogens)	Maximum Incremental Cancer Risk ≥10 in 1 million Hazard Index ≥1.0 (project increment) Hazard Index ≥3.0 (facility-wide)	
Odor	Project creates an odor nuisance pursuant to SCAQMD Rule 402	
Ambient Air Quality for Criteria Pollutants [d]		
NO2 1-hour average annual average	SCAQMD is in attainment; project is significant if it causes or contributes to an exceedance of the following attainment standards: 0.25 ppm (state) 0.053 ppm (federal)	
PM10 24-hour average annual geometric average annual arithmetic mean	$10.4\ \mu g/m^3$ (recommended for construction) [e] $2.5\ \mu g/m^3$ (operation) $1.0\ \mu g/m^3$ $20\ \mu g/m^3$	
Sulfate 24-hour average	$25\ \mu g/m^3$	
CO 1-hour average 8-hour average	SCAQMD is in attainment; project is significant if it causes or contributes to an exceedance of the following attainment standards: 20 ppm (state) 9.0 ppm (state/federal)	

[a] Source: SCAQMD CEQA Handbook (SCAQMD, 1993)
[b] Construction thresholds apply to both the South Coast Air Basin and Coachella Valley (Salton Sea and Mojave Desert Air Basins).
[c] For Coachella Valley, the mass daily thresholds for operation are the same as the construction thresholds.
[d] Ambient air quality thresholds for criteria pollutants based on SCAQMD Rule 1303, Table A-2 unless otherwise stated.
[e] Ambient air quality threshold based on SCAQMD Rule 403.

KEY: lbs/day = pounds per day ppm = parts per million $\mu g/m^3$ = microgram per cubic meter ≥greater than or equal to

(Rev. January 2006)